5.1.1.2 Registration of a Subscriber in a DCS 1900 Network

Figure 5-2 describes the message flow to support a Subscriber (DCS 1900 or IS-41) registering in a DCS 1900 system, when previously registered in an IS-41 system.

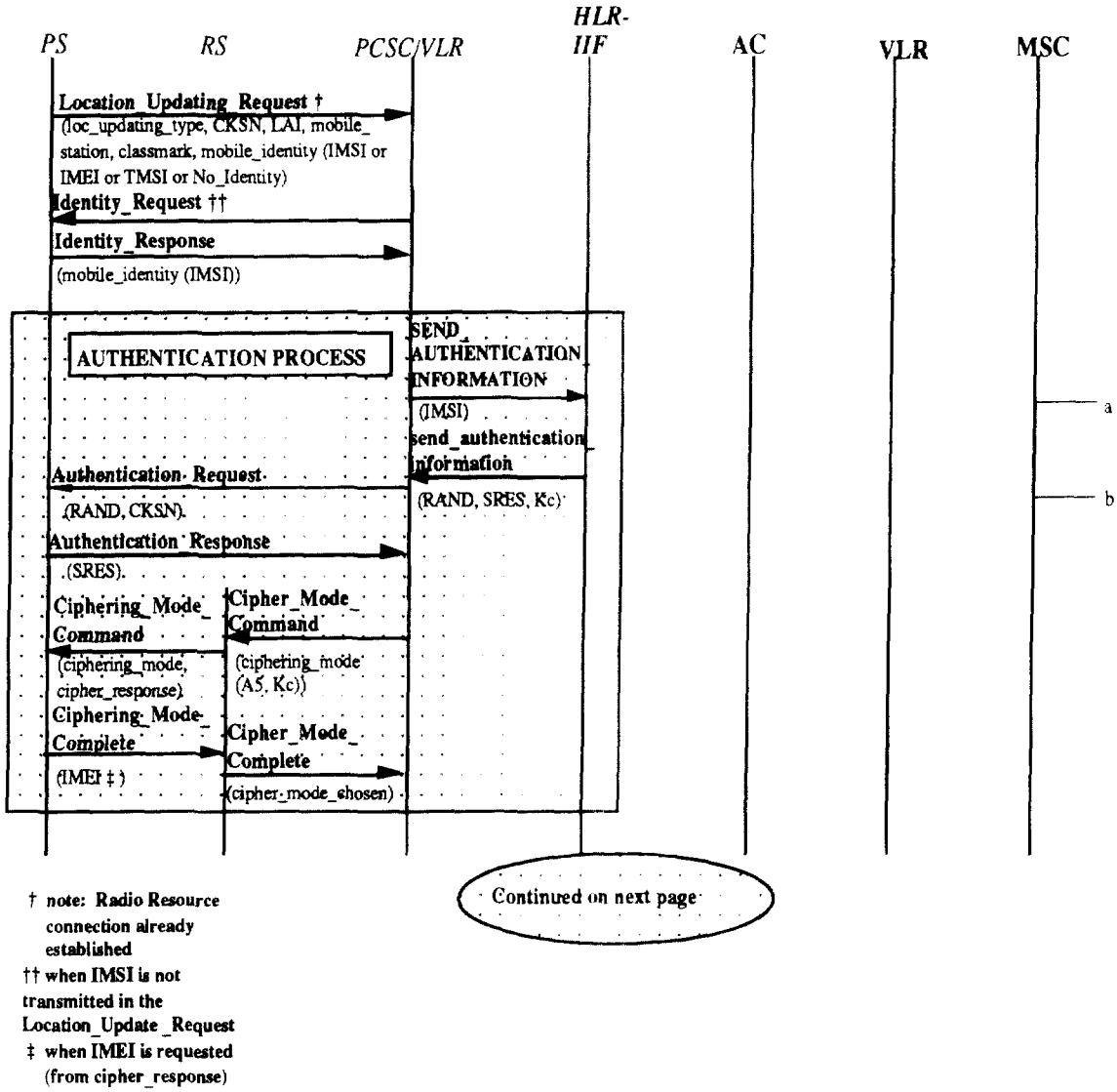

Figure 5-2. A Subscriber Registers in a DCS 1900 System (when previously registered within an IS-41 system)

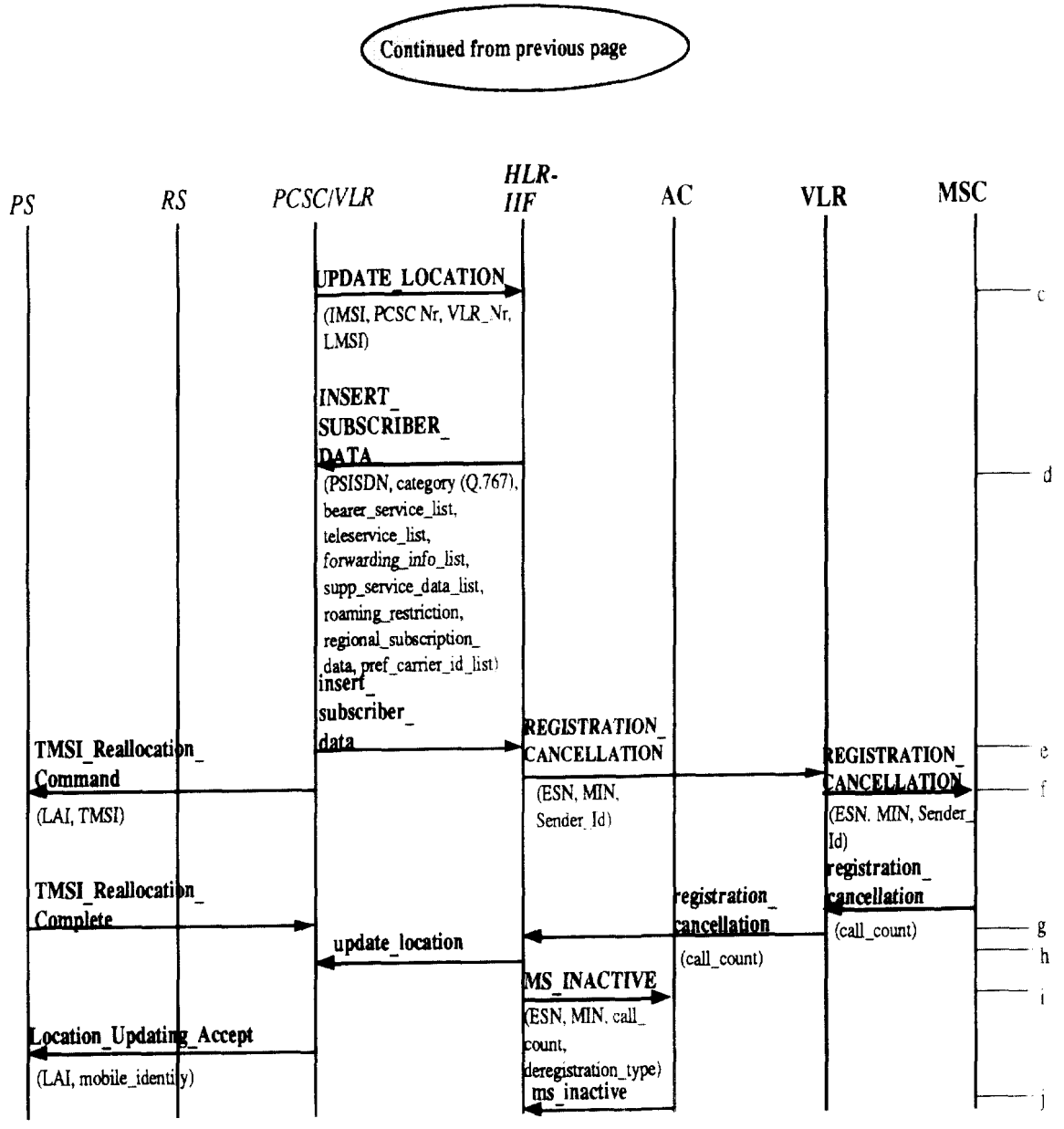

Figure 5-2 (Cont.) A Subscriber Registers in a DCS 1900 System (when previously registered within an IS-41 system)

a. On the initial registration attempt by a subscriber (DCS 1900 or IS-41) moving from an IS-41 system to a DCS 1900 system, the serving PCSC/VLR first attempts to authenticate the PS by sending to the HLR-IIF a SendAuthenticationInfo using the IMSI.

b. The HLR-IIF returns the authentication triplets to the Serving PCSC/VLR with a SendAuthenticationInfo Ack.

c. The Serving PCSC continues the registration process by sending to the HLR-IIF a Update Location (UL) using the IMSI.

d. The HLR-IIF conveys the subscriber's information to the Serving PCSC/VLR using the InsertSubscriberData (ISD) message.

e. The Serving PCSC/VLR sends an ISD Ack to the HLR-IIF.

f. The HLR-IIF validates that the IMSI is a valid subscriber and recognizes that the subscriber had previously registered in the IS-41 network and sends the previous Serving IS-41 VLR and subsequently the MSC a REGCANC using the subscriber's MIN.

g. The previous Serving IS-41 MSC and VLR purges the subscriber's information from memory and returns regcanc to the HLR-IIF. If the SSD is shared, then the IS-41 MSC and VLR sends the callhistorycount to the IS-41 HLR/IIF using registration cancellation.

h. The HLR-IIF concludes the PS registration with an UL Ack.

i. The HLR-IIF sends callhistorycount to the IS-41 AC using MSINACTIVE.

j. The IS-41 AC returns msinactive to the IS-41 HLR/IIF.

5.1.2 Call Delivery

5.1.2.1 Call Delivery to an IS-41 Subscriber in the DCS 1900 Network

Figure 5-3 describes the message flow to support a call to an IS-41 subscriber who has registered in the DCS 1900 network.

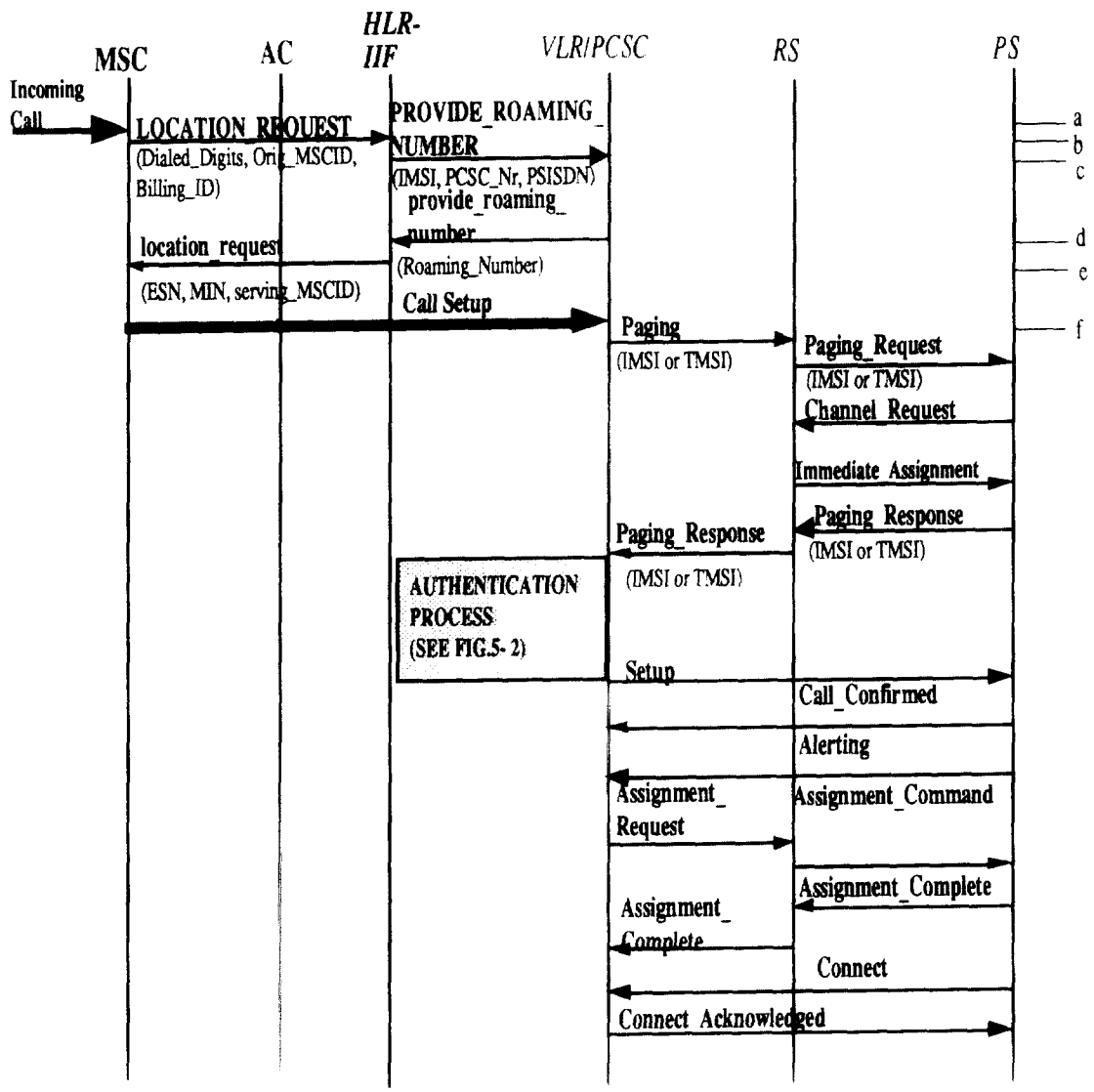

Figure 5-3 Call Delivery to an IS-41 Subscriber registered in a DCS 1900 System

via an IS-41 MSC (PS is not detached and is Idle)

a. A call, from land or mobile, destined for the PS arrives at the Originating IS-41 MSC with the Dialed Number as the called number.

b. The Originating IS-41 MSC, using the DialedNumber, sends a LOCREQ to the HLR-IIF in order to determine the location of the PS.

c. The HLR-IIF validates that the MIN associated with the dialed number is a valid subscriber and recognizes that the subscriber has registered in the DCS 1900 network and sends the Serving PCSC/VLR a Provide Roaming Number (PRN) using the IMSI (and PSISDN).

d. The Serving PCSC/VLR allocates a PSRN and returns this number to the HLR-IIF in the PRN ack

e. The HLR-IIF returns the PSRN as TLDN to the originating MSC in the locreq.

f. The Originating IS-41 MSC establishes a voice connection to the Serving PCSC/VLR using the PSRN as the called number.

5.1.2.2 Call Delivery to a DCS 1900 Subscriber in the IS-41 Network

Figure 5-4 describes the message flow to support a call to a DCS 1900 Subscriber who has registered in the IS-41 network.

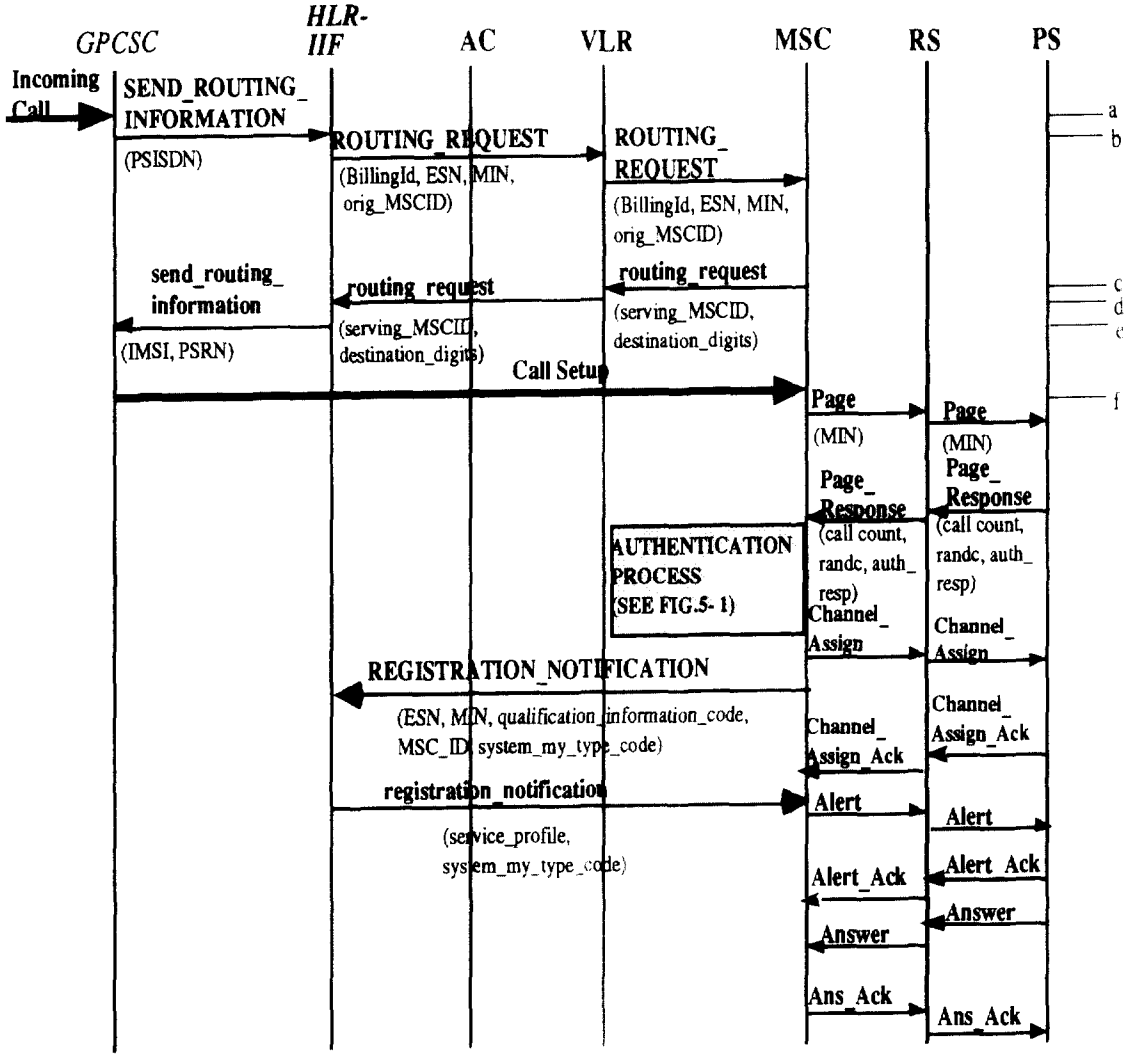

Figure 5-4 Call Delivery to a DCS 1900 Subscriber Registered in an IS-41 System via a DCS 1900 GPCSC (PS is not Inactive and is Idle)

a. A call, from land or mobile, destined for the PS arrives at the Gateway PCSC (GPCSC) with the PSISDN as the called number.

b. The GPCSC, using the PSISDN, sends a SendRoutingInformation to the HLR-IIF in order to determine the location of the PS.

c. The HLR-IIF validates that the PSISDN is a valid subscriber and recognizes that the subscriber has registered in the IS-41 network and sends the serving IS-41 VLR and subsequently the MSC a ROUTREQ using the PSISDN as the MIN. The HLR-IIF address is placed in the MSCID (Originating) allowing the serving IS-41 MSC to send the REDREQ to the HLR-IIF.

d. The serving IS-41 MSC allocates a TLDN and returns this number to the VLR and subsequently to the HLR-IIF in the routreq.

e. The HLR-IIF returns the TLDN as a PSRN to the GPCSC in the SRI ack.

f. The GPCSC establishes a voice connection to the serving IS-41 MSC using the TLDN (PSRN) as the called number.

5.1.3 Call Origination

5.1.3.1 Call Origination on an IS-41 System

Figure 5-5 describes the message flow to support a call origination in an IS-41 system from a Subscriber (IS-41 or DCS 1900)

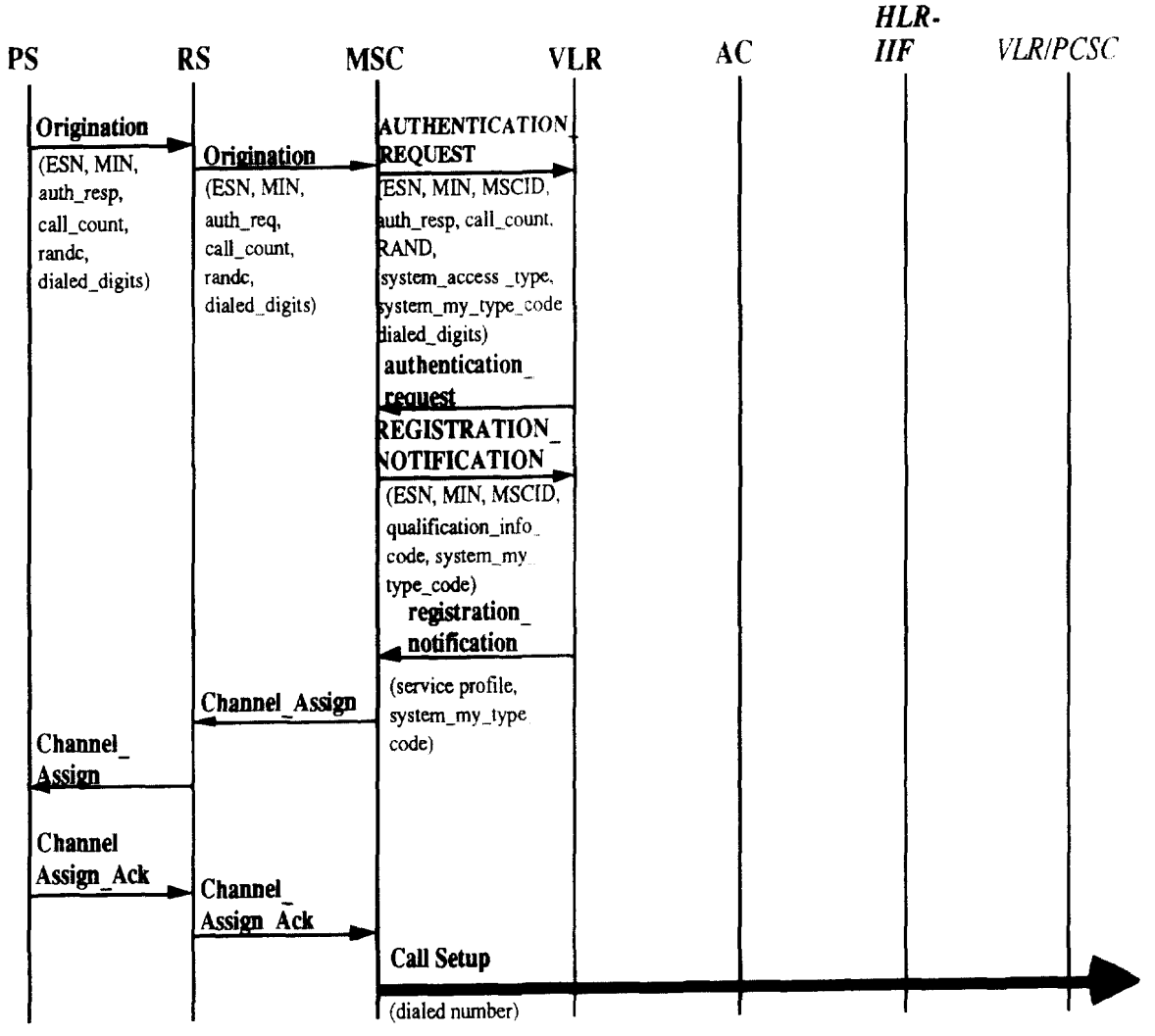

Figure 5-5 A Subscriber Originates a Call in an IS-41 System (VLR has SSD and Call Count)

5.1.3.2 Call Origination on a DCS 1900 System

Figure 5-6 describes the message flow to support a call origination in a DCS 1900 system from a Subscriber (IS-41 or DCS 1900).

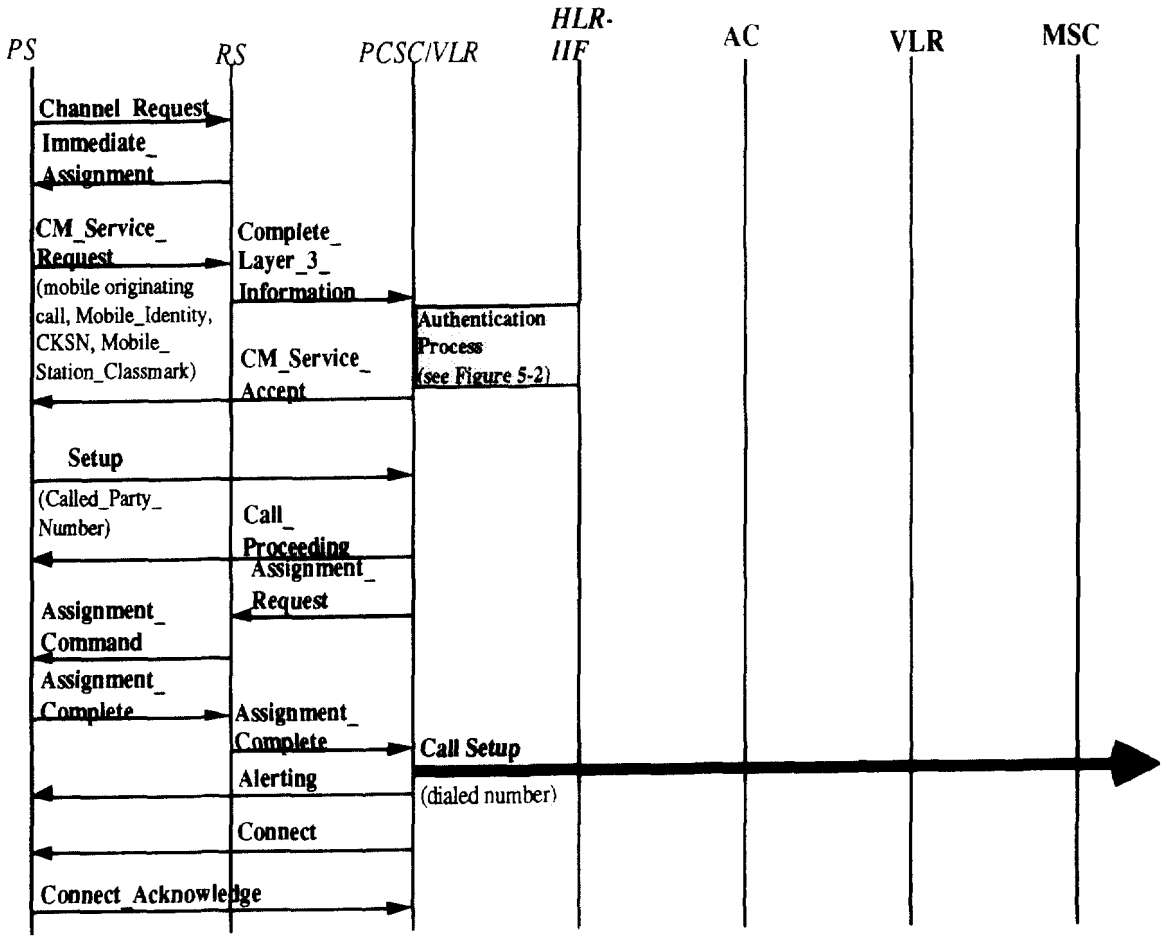

Figure 5-6 A Subscriber Originates a Call in a DCS 1900 System

(Case of early assignment: network allocates traffic channel to the PS before initiating call establishment in the fixed network)

5.2 Asynchronous Data Services

For further study.

5.3 Group 3 Facsimile

For further study.

5.4 Multi-rate Circuit Mode Unrestricted Connections

For further study.

6. Supplementary Services Interoperability

This section describes the Supplementary Service (SS) Interoperability between a DCS 1900 network and an IS-41 network.

6.1. Supplementary Services Procedures

The supplementary service (SS) procedure refers to the procedure to activate, deactivate, and interrogate the status of a service. This process changes the data in the HLR on a supplementary service of a Subscriber. Both DCS 1900 and IS-41 systems have similar, but not identical, procedures for supplementary services.

The DCS 1900 system defines call independent procedures for the supplementary services. The procedures are done through specific messages for specific supplementary services. For example, when a subscriber dials *21*NPA-NXX-XXXX#, this will result in an CFU activation message from the PS through the PCSC/VLR and to the subscribers HLR. The PS will do the translation of the feature access codes (e.g., activation, de-activation, interrogation) into the feature access messages and will send these messages to the HLR for processing. The result of this process is sent back to the PS for processing. The Man Machine Interface (MMI) procedures are defined in J-STD-007.

The IS-41 MAP defines a single procedure, i.e.: Feature Request, as the SS procedure. A brief description of the process of invocation of Supplementary Services is as follows: A call origination is made which includes dialed digits. From the dialed digits, the MSC observes that a feature control request has been made. Typically this determination is made by observing a "reach back" digit sequence which consists of a single "star" followed by other digits, i.e.: "* - digits". The dialed digits are placed into the FEATREQ (Feature Request) INVOKE and sent from the MSC to the HLR associated with the subscriber. The HLR performs a complete analysis of the dialed digits and then responds to the MSC and can include in this response various instructions for the call. For example, the MSC could be instructed to route the call to a tone or announcement, or even initiate a call delivery procedure. In addition to this call activity, if the HLR has determined that the subscribers profile has been changed in any way (for example that a new Call Forwarding number has been provided by the user), then the HLR can invoke profile updating transactions which are independent transactions from the FEATREQ RETURN RESULT.

It should be noted that due to the procedural differences between the two networks, feature transparency for some supplementary services on I&I cannot be fully achieved. Through out this section the IS-41 MSC and IS-41 VLR are shown together in a single box for simplicity, except where technical clarity requires them to be shown individually.

DCS 1900 Subscriber roaming into IS-41 Network

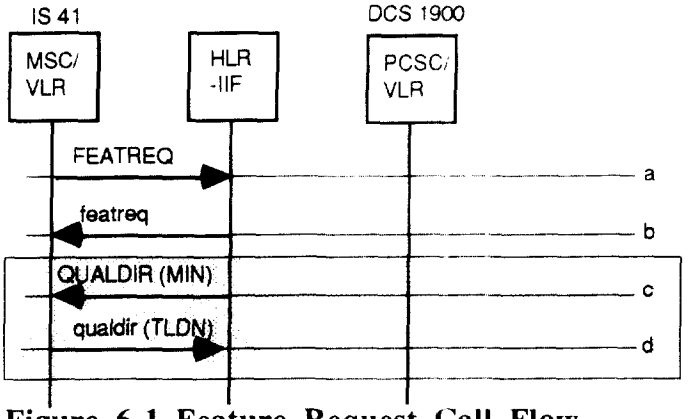

Figure 6-1 Feature Request Call Flow

a. The dialed digits are included in the FEATREQ that is sent from the serving IS-41 MSC/VLR to the HLR-IIF.

b. The HLR-IIF acts on the request by the PS and returns to the serving IS-41 MSC/VLR the feature request confirmation.

c. The HLR-IIF may also send a QUALDIR to the serving IS-41 MSC/VLR if the FEATREQ resulted in a change to the subscriber's profile.

d. The serving IS-41 MSC/VLR returns a qualdir to the HLR-IIF.

IS-41 Subscriber roaming into DCS 1900 Network

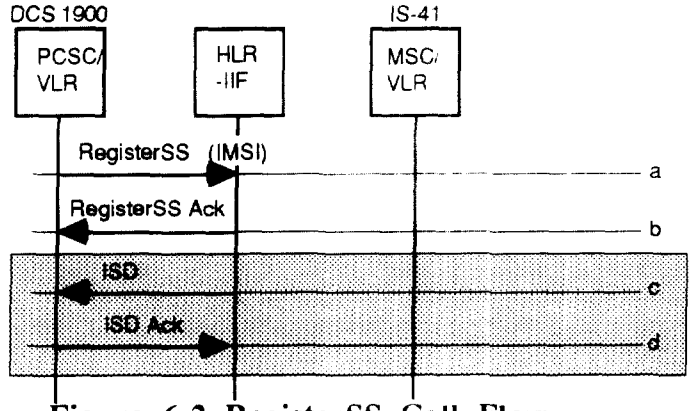

Figure 6-2 RegisterSS Call Flow

The RegisterSS message is used as an example. The HLR-IIF must also respond to the EraseSS, ActivateSS, DeactivateSS and InterrogateSS.

a. The DCS 1900 PCSC/VLR sends the RegisterSS message to the HLR-IIF.

b. The HLR-IIF performs the requested action of the RegisterSS and responds to the DCS 1900 PCSC/VLR with a RegisterSS Ack.

c. HLR-IIF may also send an Insert Subscriber Data (ISD) to the DCS 1900 PCSC/VLR if the RegisterSS resulted in a change to the subscriber's profile.

d. Serving DCS 1900 PCSC/VLR returns an ISD Ack to the HLR-IIF

6.1 Automatic Recall

For further study.

6.2 Automatic Reverse Charging

For further study.

6.3 Call Forwarding

The Call Forwarding services can be categorized into two categories; Unconditional and Conditional (e.g., Call forwarding on Busy, Call Forwarding on No Answer).

In DCS 1900, Call Forwarding Unconditional service is forwarded by the GPCSC and all Call Forwarding Conditional services are forwarded by the serving PCSC/VLR.

In IS-41, Call Forwarding Unconditional service is also forwarded by the originating MSC and Call Forwarding Conditional services can be forwarded by either the serving MSC or the originating MSC.

In order to avoid any impact on both DCS 1900 MAP protocol and IS-41 MAP protocol, it is assumed that, for I&I, Call Forwarding Conditional services be forwarded by the serving MSC/VLR. The solution is addressed in more detail in the Call Forwarding on Busy and Call Forwarding on No Answer message flows that follow.

6.3.1 Call Forwarding Unconditional (CFU)

The Call Forwarding Unconditional (CFU) supplementary service maps perfectly between DCS 1900 and IS-41 network. The forward-to-number is stored in HLR during feature registration and is provided to GPCSC when the GPCSC queries the HLR for the DCS 1900 Subscriber's whereabouts. The call is delivered to the forward-to-number from GPCSC.

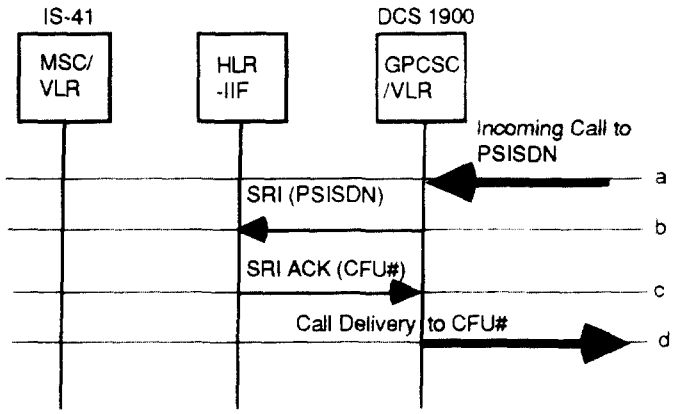

Figure 6-3 DCS 1900 Subscriber CFU Call Delivery

a. The incoming call to PSISDN first reaches DCS 1900 GPCSC.

b. The DCS 1900 GPCSC sends a query Send Routing Information (SRI) to HLR-IIF.

c. Once the HLR-IIF determines that the DCS 1900 Subscriber has been CFU activated, it returns with the SRI ACK containing the CFU number.

d. The call is forwarded to the CFU number from the DCS 1900 GPCSC.

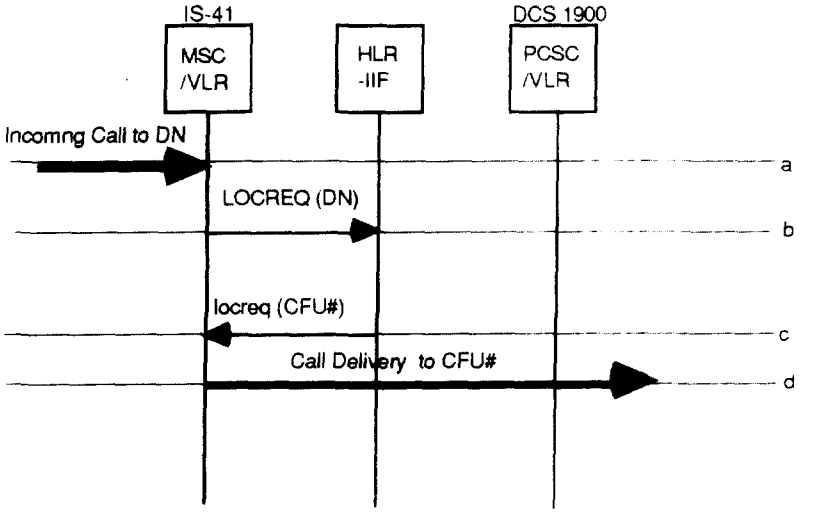

Figure 6-4 IS-41 Subscriber CFU

a. The incoming call to the DN first reaches IS-41 MSC.

b. The IS-41 MSC sends a query Send Location Request (LOCREQ) to the HLR-IIF.

c. Once the HLR-IIF determines that the IS-41 Subscriber has been CFU activated, it returns with locreq containing the CFU number.

d. The call is forwarded to the CFU number from the IS-41 MSC.

6.3.2 Call Forwarding on Busy (CFB)

In DCS 1900, the Call Forwarding on Busy (CFB) supplementary service is always invoked at the serving PCSC. That is, the call is forwarded to the CFB number from the serving PCSC. In IS-41 network, however, the CFB can be invoked at either the originating MSC or the serving MSC.

DCS 1900 Subscriber roaming into IS-41 Network

There are two possible scenarios.

In scenario 1, the serving IS-41 MSC/VLR returns a routreq response with a TLDN to the HLR-IIF. But when the call is delivered to the serving system, the CFB condition applies. Since the DCS 1900 GPCSC cannot handle an IS-41 ROUTREQ process, it is suggested that the REDREQ is sent to the HLR-IIF instead of the DCS 1900 PCSC.

In scenario 2, the CFB condition applies during the ROUTREQ process and the serving IS-41 MSC/VLR returns a routreq response with a busy indication to the HLR-IIF.

Scenario 1.

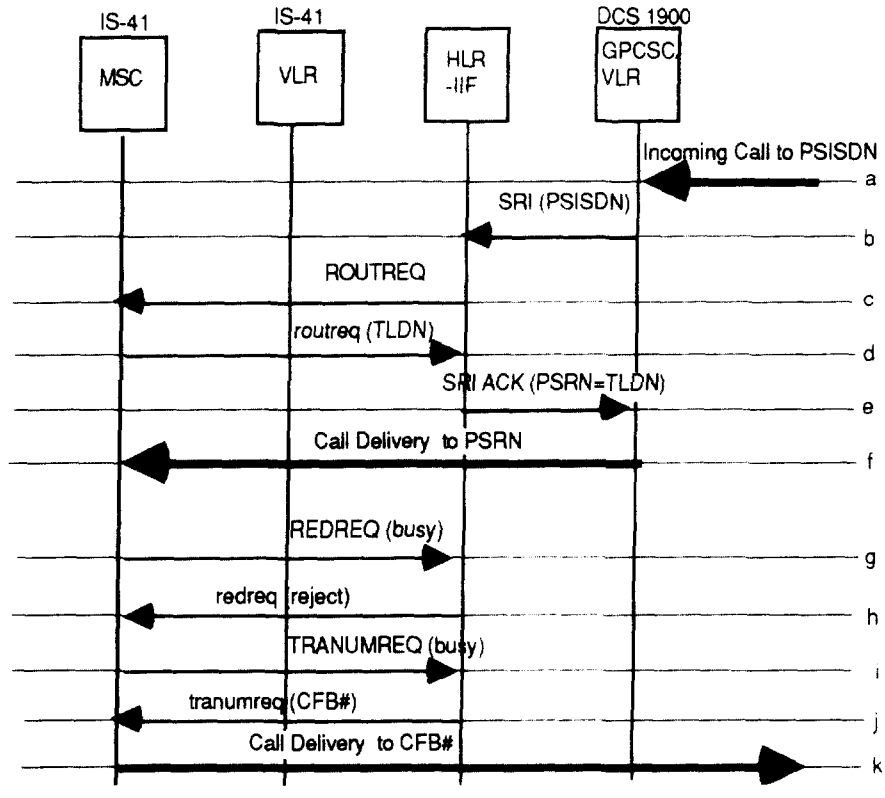

Figure 6-5 CFB (DCS 1900 Subscriber roaming into IS-41 network)

a. The incoming call to the PSISDN first reaches the DCS 1900 GPCSC.

b. The DCS 1900 GPCSC sends a query Send Routing Information (SRI) to the HLR-IIF.

c. The HLR-IIF sends the Routing Request (ROUTREQ) containing the MSCID (Originating) of the HLR-IIF (instead of the DCS 1900 GPCSC) to the serving IS-41 VLR and subsequently to the serving IS-41 MSC to allow the serving IS-41 MSC to send the REDREQ to the HLR-IIF.

d. If the serving IS-41 MSC determines that the DCS 1900 Subscriber is available, it returns the routreq containing both a busy indication or a Temporary LocalDirectory Number (TLDN) or both through the IS-41 VLR to the HLR-IIF.

e. The HLR-IIF returns with the SRI ACK containing the Personal Station Roaming Number (PSRN). (PSRN=TLDN).

f. The call is delivered from the DCS 1900 GPCSC to the serving IS-41 MSC via the TLDN allocated by the serving IS-41 MSC.

g. When CFB condition applies, the serving IS-41 MSC sends Redirection Request (REDREQ) message to the HLR-IIF based on the MSCID (Originating) received from the ROUTREQ message.

h. The HLR-IIF rejects the redirection request.

i. The IS-41 MSC sends a Transfer To Number Request (TRANUMREQ) to the HLR-IIF to ask for a CFB number.

j. The HLR-IIF returns the tranumreq with the CFB number.

k. The call is forwarded to the CFB number from the serving IS-41 MSC.

Note Steps g-k are MSC dependent. The MSC may send a TRANUMREQ to the HLR-IIF to ask for a CFB number and forward the call to the CFB number, or the MSC may simply provide busy tone to the caller.

Scenario 2.

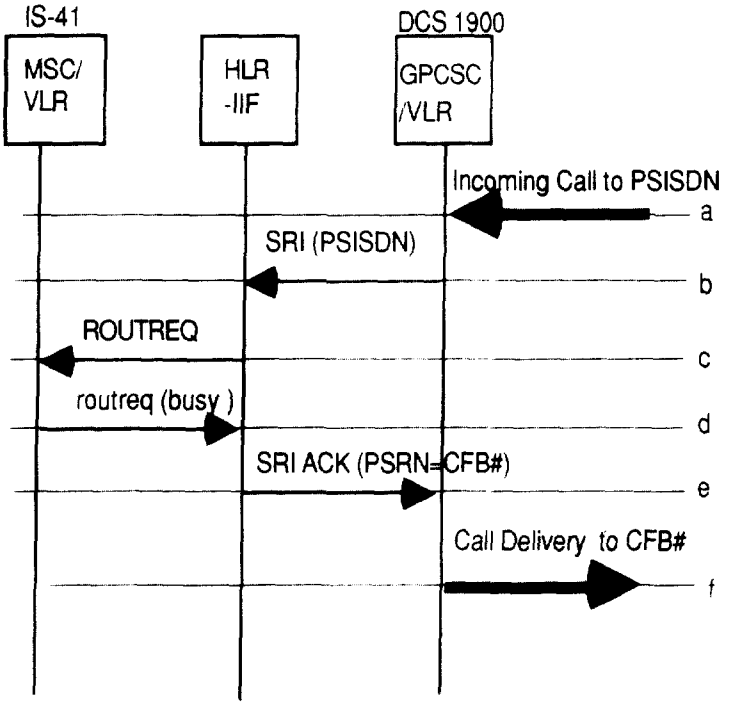

Figure 6-6 CFB (DCS 1900 Subscriber roaming into IS-41 network)

a. The incoming call to the PSISDN first reaches the DCS 1900 GPCSC.

b. The DCS 1900 GPCSC sends a query Send Routing Information (SRI) to the HLR-IIF.

c. The HLR-IIF sends the Routing Request (ROUTREQ) containing the MSCID (Originating) of the HLR-IIF (instead of the DCS 1900 GPCSC) to the serving IS-41 MSC/VLR to allow the serving IS-41 MSC/VLR to send the REDREQ to the HLR-IIF.

d. If the serving IS-41 MSC/VLR determines that the DCS 1900 Subscriber is busy, it returns the routreq containing a busy indication to the HLR-IIF.

e. The HLR-IIF returns with the SRI ACK containing the Personal Station Roaming Number (PSRN). (PSRN=CFB#).

f. The call is forwarded to the CFB number from the serving GPCSC.

IS-41 Subscriber roaming into DCS 1900 Network

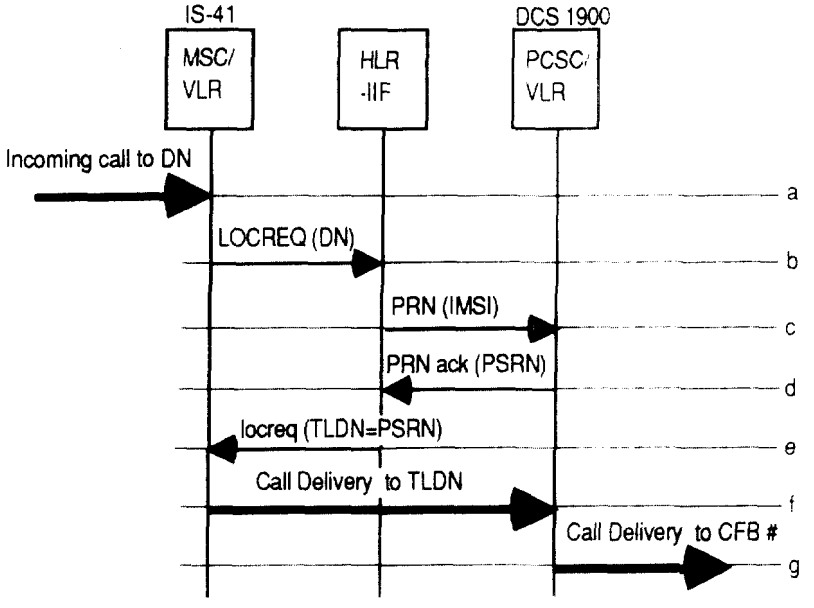

Figure 6-7 CFB (IS-41 Subscriber roaming into DCS 1900 network)

a. The incoming call to the DN first reaches the IS-41 MSC.

b. The IS-41 MSC sends a query Location Request (LOCREQ) to the HLR-IIF.

c. The HLR-IIF sends a Provide Roaming Number (PRN) to the serving DCS 1900 PCSC/VLR.

d. The serving DCS 1900 PCSC/VLR returns with the PRN ACK containing the Personal Station Roaming Number (PSRN) to the HLR-IIF.

e. The HLR-IIF returns with the locreq containing a Temporary Local Directory Number (TLDN) to the IS-41 MSC (TLDN=PSRN).

f. The call is delivered from the IS-41 MSC to the serving DCS 1900 PCSC/VLR via the PSRN allocated by the serving DCS 1900 PCSC/VLR.

g. After the determination of user busy, and CFB activated, the call is forwarded to the CFB number

6.3.3 Call Forwarding on No Answer (CFNA)

In DCS 1900, the Call Forwarding on Busy (CFB) supplementary service is always invoked at the serving PCSC. That is, the call is forwarded to the CFB number from the serving PCSC.

DCS 1900 Subscriber roaming into IS-41 Network

To avoid impact on both DCS 1900 MAP and IS-41 MAP protocol, for I&I, when the Call Forwarding condition applies, the REDREQ message is sent to the HLR-IIF instead of to the DCS 1900 GPCSC

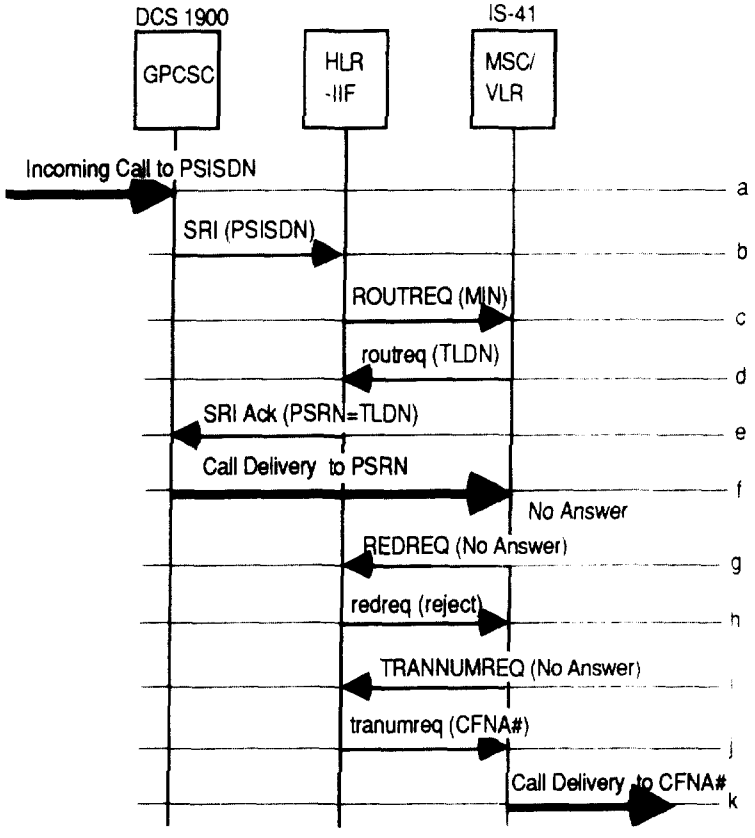

Figure 6-8 CFNA (DCS 1900 Subscriber roaming into IS-41 network)

a. The incoming call to the PSISDN first reaches the DCS 1900 GPCSC.

b. The DCS 1900 GPCSC sends a query Send Routing Information (SRI) to the HLR-IIF.

c. The HLR-IIF sends the Routing Request (ROUTREQ) containing the MSCID (Originating) of the HLR-IIF (instead of the DCS 1900 GPCSC) to the serving IS-41 MSC/VLR to

allow the serving IS-41 MSC/VLR to send the REDREQ to the HLR-IIF.

d. Serving IS-41 MSC/VLR returns routreq containing Temporary Local Directory Number (TLDN) to the HLR-IIF.

e. The HLR-IIF returns with the SRI ACK containing a Personal Station Roaming Number (PSRN). (PSRN=TLDN).

f. The call is delivered from the DCS 1900 GPCSC to the serving IS-41 MSC/VLR via the TLDN allocated by the serving IS-41 MSC/VLR.

g. When CFNA condition applies, the serving IS-41 MSC/VLR sends a Redirection Request (REDREQ) message to the HLR-IIF based on the MSCID (Originating) received from the ROUTREQ message.

h. The HLR-IIF rejects the redirection request.

i. The IS-41 MSC/VLR sends a Transfer To Number Request (TRANUMREQ) to the HLR-IIF to ask for a CFNA number.

j. The HLR-IIF returns the tranumreq with a CFNA number.

k. The call is forwarded to a CFNA number from the serving IS-41 MSC/VLR.

Note: The visited system may not support the Transfer_to_Number Request message and steps i-k will not occur.

IS-41 Subscriber roaming into DCS 1900 Network

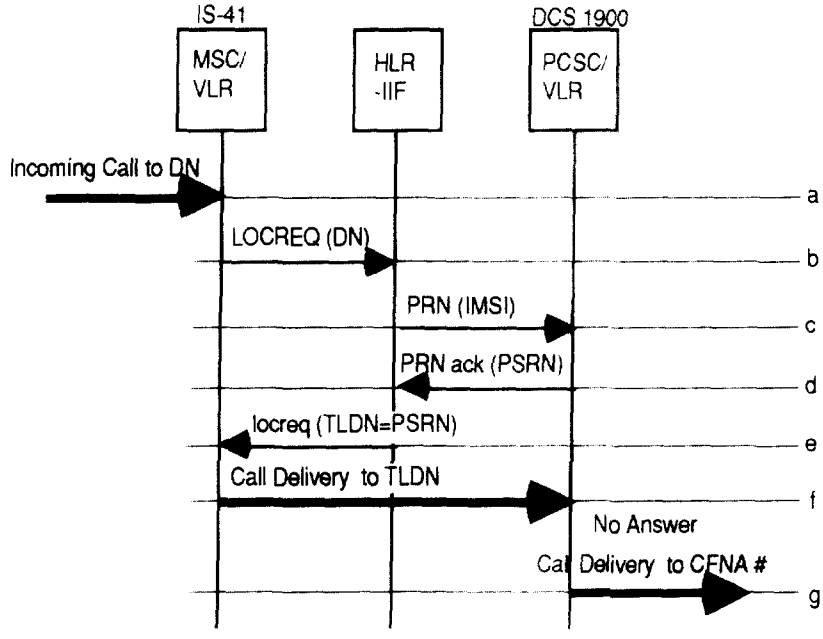

Figure 6-9 CFNA (IS-41 Subscriber roaming into DCS 1900 network)

a. The incoming call to the DN first reaches the IS-41 MSC.

b. The IS-41 MSC sends a query Location Request (LOCREQ) to the HLR-IIF.

c. The HLR-IIF sends a Provide Roaming Number (PRN) to the serving DCS 1900 PCSC/VLR.

d. The serving DCS 1900 PCSC/VLR returns with the PRN ACK containing a Personal Station Roaming Number (PSRN) to the HLR-IIF.

e. The HLR-IIF returns with the locreq containing a Temporary Local Directory Number (TLDN) to the IS-41 MSC (TLDN=PSRN).

f. The call is delivered from the IS-41 MSC to the serving DCS 1900 PCSC via the PSRN allocated by the serving DCS 1900 PCSC.

g. When the CFNA condition applies, the call is forwarded to the CFNA number from the DCS 1900 PCSC/VLR.

6.3.4 Call Forwarding on Not Reachable (CFNR)

Call Forwarding on Not Reachable can be invoked for various reasons including the subscriber (DCS 1900 or IS-41) is inactive (PS turned off), no page response, etc.

From the I&I point of view, two cases require different interactions towards the HLR-IIF. In the first case, call forwarding occurs prior to call delivery. In the other case, call forwarding takes place after the call is delivered to the serving system.

DCS 1900 Subscriber roaming into IS-41 Network Call Forwarding after Call Delivery.

Figure 6-10 describes the example message flow for the 'No Page Response" case. The same message flow applies to "Unavailable (after call delivery)", "Call Refused", etc.

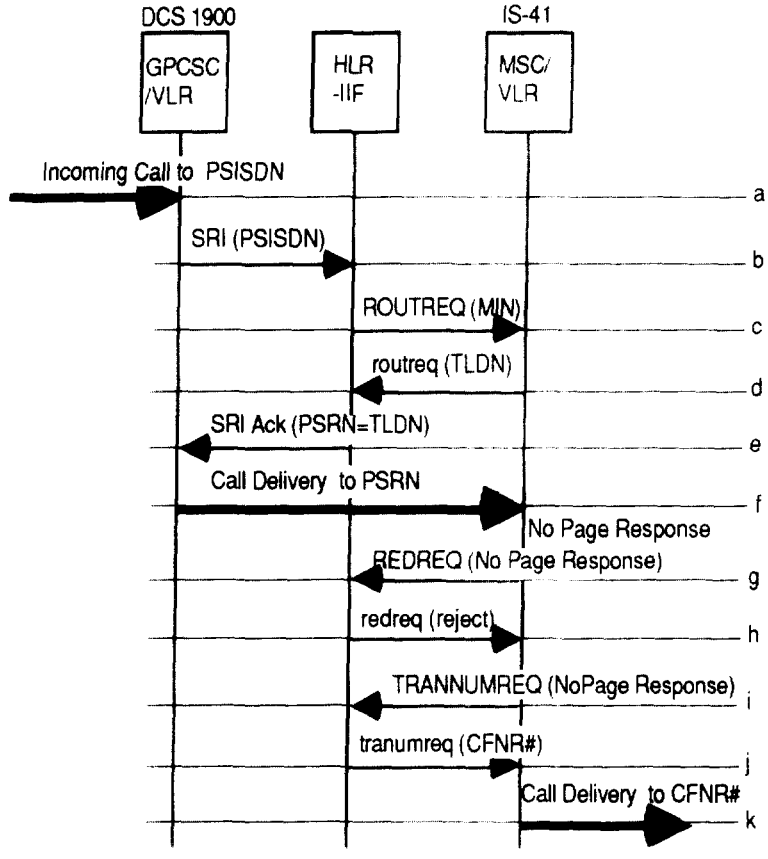

Figure 6-10 CFNR - No Page Response Case (DCS 1900 Subscriber roaming into IS-41 network)